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13. ABSTRACT (Maximum 200 words)

When two-phase mixtures of ductile metals are mechanically alloyed, they often assume a convoluted lamellar structure. Since these powders are consolidated at elevated temperatures, their structures (and therefore properties) are likely to be altered by consolidation processing. We have investigated microstructural changes that take place on heat-treating mechanically alloyed Cu-20 vol.% NB alloys. The transition from a "plate-like" to a spherical microstructure is described and the kinetics of this process appear controlled by a type of boundary diffusion even though the coarsening temperature was high in terms of the homologous temperature of Cu. Reasons for this behavior are suggested. Finally, during heat treatment (carried out in hydrogen), a Nb layer forms around the particles. The thickness of this layer (and the corresponding zone denuded of Nb within the particle) increases with continued elevated temperature exposure, and at a rate consistent with the process being driven by curvature forces.

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Mr. Robert J. Comstock, Jr. was supported by this grant during the above period. Mr. Comstock completed requirements for the M.S. degree in Materials Science and Engineering at the University of Virginia in May, 1993.

Mr. Comstock's M.S. thesis dealt with the elevated temperature stability of mechanically alloyed ductile metals. The topic is important since mechanically alloyed powders must be densified to render them useful engineering solids. Their consolidation invariably requires exposure to elevated temperatures. During this exposure, the structure of the powders is altered and, as a result, so are the material properties. It is worthwhile to classify and identify the structural changes that take place with the end purpose of monitoring and controlling microstructure during consolidation.

Mr. Comstock investigated the temperature stability of mechanically alloyed Cu-20 vol. % Nb alloys. These were alloyed in a SPEX mill for various times and then heat-treated (at a temperature close to the melting point of Cu), also for varying periods. As the two metals are insoluble in each other, the "alloyed" structure consists of an irregular lamellar array of them; this structure arises from the repetitive "forging" associated with MA. Interlamellar spacings in as-milled powders range from several tenths (at long milling times, on the order of an hour) to several micrometers (material milled for 20 min).

On heat-treating for sufficient times, the lamellar structure evolves into a spherical dispersion of Nb particles in the Cu matrix. The time required for this evolution is long for short milling times and vice-versa. This results from the variation of interlamellar spacing with milling time; thicker lamellae take longer to "split" into smaller fragements, this splitting process precedes the eventual spheroidization. Kinetic analysis indicates the evolvement of the structure is consistent with previously postulated kinetics developed for more "ideal" lamellar arrays. In addition, we suggest boundary diffusion controls the instability process, surprising in light of the high homologous temperature employed. Nonetheless, the subseqeuent Ostwald ripening behavior of the spherical dispersion also supports this contention. It is suggested these results arise from the initially heavily cold-worked structure of the alloyed product which, on recrystallization, yields a very fine (slightly greater than the nanometer scale) susbstructure.

Two papers have come from Mr. Comstock's efforts. The first was an invited paper at the Symposium on Coarsening and Grain Growth held at the Fall Meeting of TMS in November, 1992 (Paper title: "Elevated Temperature Stability of Lamellar Structures with Specific Application to Mechanical Alloying", to be published in the Proceedings of this Symposium) and a paper now nearly ready for submission to an archival journal ("Elevated Temperature Stability of Mechanically Alloyed Cu-Nb Powders).